FDI, INFLATION, EXCHANGE RATE AND GROWTH IN GHANA: EVIDENCE FROM CAUSALITY AND COINTEGRATED ANALYSIS

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Abstract

This study used co-integrated analysis and Granger causality test in modelling the Growth Domestics Products (GDP) of Ghana with other three selected macroeconomic such as Foreign Direct Investment (FDI), inflation and real exchange rate for the period of 1980 to 2013. Data were taken from the World Bank's World Development Indicators and Bank of Ghana. The objectives of the study are to examine both long-run relationships and direction of causality between the GDP and the macroeconomic variables. The time series properties of the data were, first, analysed using the Augmented Dickey-Fuller (ADF) test and KPSS test. The empirical results derived indicate that all the variables were stationary after their first differencing; i.e. variables are integrated of order one. The study further established that there is co-integration between the selected macroeconomic variables and GDP in Ghana indicating long run relationship. The above long term relation indicates that exchange rate and foreign direct investments have a negative effect on GDP whiles Inflation (CPI) showed a positive effect on GDP. The study further investigated the causal relationship using the Granger Causality analysis, which indicates a unidirectional causality between GDP growth rate and exchange rate and bidirectional causality between Inflation rate and Exchange, and also between Inflation rate and GDP, whiles FDI does not granger cause Inflation rate, exchange rate, GDP and visa versa in Ghana for the study period at 5%.

Keywords: GDP, Granger causality test, co-integration

Introduction

The issues of GDP has become the most concerned amongst macro economy variables and data on GDP is regarded as the important index for assessing the national economic development and for judging the operating status of macro economy as a whole (Ning et al. 2010).

There are several studies done on the selected macro-economic variables and economic growth. Their findings vary from different methods used on their research, for instance, Ahmed and Mortazat (2005) utilized annual data for the period of 1980 to 2005 to study the relationship between inflation and economic growth in Bangladesh. On the relationship between inflation and economic growth, the results from the Johansen and granger causality tests imply that there is a negative relationship between inflation and growth and a unidirectional causality running from inflation to growth. In addition, a study by Elias et al. (2012) on the long run relationship between inflation and economic growth in Bangladesh over the period 1978 to 2010, they use the Augmented Dickey-Fuller (ADF) and Phillip-Perron(PP) tests. The results agree with those of Ahmed and Mortazat that inflation relates negatively with growth in Bangladesh.

Philip (2010) employed the Johansen co-integration technique to study the relationship between inflation and growth in Nigeria using annual data spanning from 1970 to 2005. The results of the study indicated that for the period of study, there was a negative co integration relationship between inflation and growth in Nigeria. The Engle and Granger Causality test was used to further check the causality relationship between the two variables. The study also established a uni- directional causality running from inflation to growth.

There have been certain theories presented propounding a relationship between real exchange rate and country's output in terms of GDP. For instance, Abu Bakaar (2010) examines the real effect of exchange rate on economic growth of Sierra Leone. He uses quarterly data for the period of 1990-2006 for his analysis to investigate the relation with the help of Granger causality tests. He finds positive correlation between real effective exchange rate and economic growth of Sierra.

There are several studies done on FDI and economic growth. For example Frimpong and Abayie (2006) examine the causal link between FDI and GDP growth for Ghana for the pre and post structural adjustment program (SAP) periods and the direction of the causality between two variables. Annual time series data covering the period from 1970 to 2005 was used. The study finds no causality between FDI and growth for the total sample period and the pre-SAP period. According to the findings of Choe (2003), causality between economic growth and FDI runs in either direction but with a tendency towards growth causing FDI; there is little evidence that FDI causes host country growth. Rapid economic growth could result in an increase in FDI inflows. This paper aims to study the causality and co-integrated relationship between inflation, exchange rate, FDI and economic growth in Ghana for the period 1980-2013 using time series data.

Methodology

Source of Data and Data Collection Procedure

The study employs secondary data. Time series annual data on inflation (CPI), real exchange, FDI and real GDP growth from Ghana over the study period 1980 to 2013 are used for the study, which gives thirty three (33) data points which is statistically large to be used for the study. Data was obtained from Bank of Ghana and WDI, World Bank.

Analysis Plan

In analysing the dataset the following tests are expected to be employed: Unit root test for stationarity, ADF (Augmented Dickey Fuller) test and KPSS (Kwiatkowski, Phillips, Schmidt and Shin, 1992) test, Co-integration test, Vector error correction model (VECM), etc. We rely on Eviews 8 statistical computing software to implement the time series methods that will be discussed and all statistical tests were carried out at 0.05 level of significance.

Unit Root Tests

Unit root tests are applied to check whether the time series is stationary. Many unit root tests are proposed in the literature. In this paper we used three tests namely ADF (Augmented Dickey Fuller) test and KPSS (Kwiatkowski, Phillips, Schmidt and Shin, 1992) test.

The Dickey-Fuller test is based on testing the hypothesis that series contains unit root against the series is stationary under the assumption that errors are white noise. The test may be carried out using a conventional *t* statistic. However, the tests do not follow the standard student t distribution so the critical values for the test are obtained by simulation. An extension which will accommodate some forms of serial correlation is the augmented Dickey–Fuller test.

KPSS proposed an LM test for testing trend and/or level stationarity. That is, now under the null hypothesis the series is assumed stationary, whereas in the former tests it was a unit root process. Taking the null hypothesis as a stationary process and the unit root as an alternative is in accordance with a conservative testing strategy. One should always seek tests that place the hypothesis we are interested in as the alternative one. Hence, if we then reject the null hypothesis, we can be confident that the series indeed has a unit root.

Co-integration Test

Two broad approaches for co-integration have been developed. These are Engle and Granger (1987) method and the Johansen approach, due to Johansen (1998), based on vector autoregressive model (VAR) (Green, 2003).

There are two types of tests for Johansen co-integration approach called trace test and the maximum eigenvalue test. The test statistics for the trace test and maximum eigenvalue test are shown in the following equations [1] and [2] respectively.

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1-\lambda_i) \qquad [1]$$

$$J_{max} = -T \ln(1-\lambda_{r+1}) \qquad [2]$$

Where T is the sample size, n is number of endogenous variables and $\lambda_i$is thelargest eigenvalue. The trace test tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of n co-integrating vectors. The maximum eigenvalue test, on the other hand, tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of r +1 co-integrating vectors where r =1,2,.....n.

The variance decomposition was used to analyse the proportion of the unanticipated change of a variable that is attributable to its own innovations and shocks to other variables in the system.

Vector Error Correction Model (VECM)

VECM is a kind of VAR model used with co-integration restrictions. Since the variables included in the VAR model are found to be co-integrated, the next step is to specify and estimate a vector error correction model (VECM) including the error correction term to investigate dynamic behaviour of the model.

The Johansen's (1988) technique employs the Vector Error Correction Model (VECM):

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta y_{t-1} + \varepsilon_t \qquad [3]$$

Where Γ_i is a square matrix whose elements depend on the coefficients of long run model and y_t contains the endogenous variables of the model. The Π is a g x r matrix containing the long-run parameter, Δ is the first difference operator and ε_t is the white noise term.

If there are r co-integration vectors then Π can be expressed as a product of two matrices as $\Pi = \gamma\beta'$ where both γ and β are g x r matrices. The matrix β contains the coefficients of long-run relationship and γ contains the speed of adjustment parameters which are also interpreted as the weight with which each co-integration vector appears in a given equation.

If there are '*r*' co-integration relationships, the matrix Π is expressed as product of two matrices each of which is of order g x r i.e. $\Pi = \gamma\beta'$. For example if r = 1, the VECM will be written as (for g = 4 variable system)

$$\begin{pmatrix}\Delta y_{1t}\\ \Delta y_{2t}\\ \Delta y_{3t}\\ \Delta y_{4t}\end{pmatrix} = \begin{pmatrix}\delta_1\\ \delta_2\\ \delta_3\\ \delta_4\end{pmatrix} + \begin{pmatrix}g_{11} & \cdots & g_{14}\\ \vdots & \ddots & \vdots\\ g_{41} & \cdots & g_{44}\end{pmatrix}\begin{pmatrix}\Delta y_{1,t-1}\\ \Delta y_{2,t-1}\\ \Delta y_{3,t-1}\\ \Delta y_{4t-1}\end{pmatrix} +$$

$$\begin{pmatrix}\gamma_{11}\\ \gamma_{12}\\ \gamma_{13}\\ \gamma_{14}\end{pmatrix}(\beta_{11} \quad \ldots.. \quad \beta_{14})\begin{pmatrix}y_{1,t-1}\\ y_{2,t-1}\\ y_{3,t-1}\\ y_{4t-1}\end{pmatrix} + \begin{pmatrix}\varepsilon_{11}\\ \varepsilon_{12}\\ \varepsilon_{13}\\ \varepsilon_{14}\end{pmatrix} \quad [4]$$

Model diagnostics

While we estimate the model parameters, it is also necessary to do model diagnostics, in order to check whether the fitted model is appropriate. Portmanteau and Breusch-Godfrey-LM tests are standard tools for checking residual auto-correlation in VAR models.

Jarque-Bera is a test statistic for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution.

Structural Analysis by Granger Causality

In order to investigate the causal relationship between the variables of the system, the linear Granger causality tests should be applied by using following strategy.

Compare the unrestricted models;

$$\Delta y_t = a_1 + \sum_{i=1}^{m_1} \beta_{1i}\Delta y_{t-i} + \sum_{j=1}^{m_2} \theta_{1i}\Delta y_{j-i} + e_{1t} \qquad [5]$$

$$\Delta x_t = a_2 + \sum_{i=1}^{m_1} \beta_{2i}\Delta x_{t-i} + \sum_{j=1}^{m_2} \theta_{2i}\Delta x_{j-i} + e_{2t} \qquad [6]$$

With the restricted models

$$\Delta y_t = a_1 + \sum_{i=1}^{m_1} \beta_{1i}\Delta y_{t-i} + e_{1t} \qquad [7]$$

$$\Delta y_t = a_2 + \sum_{i=1}^{m_1} \beta_{2i}\Delta x_{t-i} + e_{1t} \qquad [8]$$

Where $\Delta x_t$and $\Delta y_t$are the first order forward differences of the variables, α,β, $\theta$are the parameters to be estimated and, e_1,$e_2$are standard random errors. The lag order m are the optimal lag orders chosen by information criteria. The equations described above, are convenient tools for analysing linear causality relationship between the variables. If $\theta_1$statistically significant, and $\theta_2$is not, it can be said that changes in variable y Granger cause changes in variable x or vice versa. If both of them are statistically significant there is a bivariate causal relationship between the variables, if both of them are statistically insignificant neither the changes in variable y nor the changes in variable x have any effect over other variable.

Model Results and Discussion

Unit Root Test

Tables 1 and 2 summarize the results of unit root test for ADF test and KPSS test. From the results, all the variables are non-stationary at levels but stationary in the first difference since the p-values are greater than 0.05 at the levels but the p-values are less than 0.05 in the first difference for the ADF test and also with the KPSS test all the variables are non-stationary at levels but stationary in the first difference since the p-values are less than 0.05 at the levels but the p-values are greater than 0.05 in the first difference , leading to non-rejection of null hypothesis at these levels but null hypothesis is rejected at first difference. Hence the series are integrated of order one (1) i.e. I (1), which provided a necessary, but not sufficient rationale for estimating co-integration and error correction model. Knowing this leads to the testing of Long Run relationship between the macroeconomic Variables and GDP.

Table 1: The ADF unit root test for identification of order of integration of the variables

Levels			First Difference	
Var Trend	t-statistic	prob.	t-statistic	prob.
GDP	-2.778257	0.0723	-7.153836	0.0000
FDI	-2.677302	0.0887	-4.340542	0.0017
Inflation	-2.187173	0.2146	-7.925575	0.0000
Exchange	-2.187173	0.0887	-7.153836	0.0000

Table 2: The KPSS unit root test for identification of order of integration of the variables

Levels			First Difference	
Var Trend	t-statistic	prob.	t-statistic	prob.
GDP	6.912219	0.0000	0.342977	0.7339
FDI	5.063932	0.0000	0.901740	0.3739
Inflation	5.311181	0.0000	-0.855665	0.3985
Exchange	2.992224	0.0052	-0.183537	0.8555

Co-integration Test

The results are presented in Table 3 and 4 for trace and maximum eigenvalue test for co-integration. The trace statistic either rejects the null hypothesis of no co-integration among the variables or does not reject the null hypothesis that there is one co-integration relation between the variables. Start by testing: $r = 0$. If it rejects, repeat for: $r = 1$. When a test is not rejected, stop testing there and that value of r is the commonly-used estimate of the number of co-integrating relations. In the trace statistic, $r = 1$ is not rejected at the 5% level ($24.26523 < 29.79707$) and the eigenvalue also does not rejects the null hypothesis when rank (π) =1.

In other words, the trace test and eigenvalue result does not reject the null hypothesis that these four variables are not co-integrated. The final number of co-integrated vectors with two lags is equal to one, i.e. rank (π) =1.

Table 3: Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. Of CE(s)	Eigenvalue	Trace Statistics	0.05 Critical Value	Prob.**
None*	0.654141	57.17866	47.85613	0.0052
At most 1	0.412826	24.26523	29.79707	0.1895
At most 2	0.221137	7.759766	15.49471	0.4915
At most 3	0.000395	0.012261	3.841466	0.9116

Table 4: Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. Of CE(s)	Eigenvalue	Trace Statistics	0.05 Critical Value	Prob.**
None*	0.654141	32.91343	27.58434	0.0094
At most 1	0.412826	16.50546	21.13162	0.1967
At most 2	0.221137	7.747505	14.26460	0.4049
At most 3	0.000395	0.012261	3.841466	0.9116

Vector Error Correction Model

Table 5 Vector Error Correction Model (VECM) Results.

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.786378	0.182456	-4.309963	0.0000
C(2)	0.087029	0.186020	0.467848	0.6411
C(3)	-0.277198	0.193716	-1.430949	0.1562
C(4)	0.084927	0.022957	3.699343	0.0004
C(5)	0.008907	0.027579	0.322963	0.7475
C(6)	-0.867607	0.294085	-2.950193	0.0041
C(7)	-0.453634	0.380840	-1.191142	0.2370
C(8)	-0.002991	0.001591	-1.879927	0.0636
C(9)	-0.001254	0.001316	-0.952746	0.3435
C(10)	0.967786	0.384057	2.519900	0.0136

Equation: D(GDP) = C(1)*(GDP(-1) + 0.0878257320755*INFLATION(-1) - 0.594341719086*FDI(-1) - 0.00251380119461*EXCHANGE(-1) - 4.82968950265) + C(2)*D(GDP(-1)) + C(3)*D(GDP(-2)) + C(4) *D(INFLATION(-1)) + C(5)*D(INFLATION(-2)) + C(6)*D(FDI(-1)) + C(7) *D(FDI(-2)) + C(8)*D(EXCHANGE(-1)) + C(9)*D(EXCHANGE(-2)) + C(10)

R-squared	0.770579	Mean dependent var	0.453419
Adjusted R-squared	0.672255	S.D. dependent var	3.332384
S.E. of regression	1.907757	Sum squared resid	76.43028
Durbin-Watson stat	2.267842		

Long-Run Relationship: Analysis and Discussions

The results presented in table 5 above confirm the long run relationship between the variables used in this paper. The value of (C1) represents the error correction term in the VECM and for there to be a long-run relationship, the value of C1 must be negative and its P-value must also be significant at 5% levels. From table 5, the value of C1 is -0.786378 and its P-value is 0.0000, at 5% level of significance. Thus, the variables in the model have long-run relationship, meaning also that in the long-run, the independent variables; FDI, Inflation and Exchange rate have impact on GDP annual growth rate.

The error correction term (C1) indicates the rate at which the disequilibrium between the long-run and the short-run estimates are corrected for. The results in table 5 show that on annual basis, 78.6% of the disequilibrium between the long-run and short-run estimates are corrected and brought back to equilibrium. This value is highly significant with a p-value of 0.0000 at 5% confidence level and a corresponding standard error of 0.182456. Also the R^2 of this model is 77.1% which means that the independent variables in the model are able to explain more than 70% of the variations in the dependent variable. Furthermore, the Durbin Watson value (2.3) from the model is higher than the R^2 value (0.77). This also adds to the validity of the model.

Specifically, the results as shown in the VECM equation above (see bold) indicates that a 1% increase in inflation will lead to a corresponding increase of 0.087% in GDP growth. Also, in the presence of co-integration, in the long run, a 1% increase in FDI will cause a corresponding decrease of 0.594% in GDP. The results of the VECM also indicate that in the long run, Exchange rate has a negative impact on GDP growth. That is, a 1% increase in Exchange rate will lead to a decrease of 0.0025% in GDP in the long run.

Short-Run Relationship: Analysis and Discussions

The short-term relationships among the selected variables and real GDP growth are showed in table 5 (C2-C9). One reason for the advantage of the VECM is that it allows for short run estimates for both one period and two period lags. But our analysis is basically on one period lag variables of the annual series. At one period lag, a 1% increase in annual inflation rate in Ghana will lead to a corresponding increase of 0.084% in GDP growth rate in the short run (See C4). The one period lag co-efficient of FDI is negative, which means a 1% increase in FDI will cause a decrease of 0.867% in GDP in the short run (See C6). Finally, Exchange rate has a short term negative but insignificant impact on GDP annual growth rate of Ghana (See C8).

VECM Model Checking

The results of Table 6 shows that the null hypothesis of no residual autocorrelations will be accepted for Portmanteau Tests for Autocorrelations for 11 lags out of the 12 lags since their p- values are greater than the significance values of 0.05 for the 5% significant levels and 1 lags rejects the null hypothesis that there is serial autocorrelation. Hence we can conclude that there is no serial autocorrelation since the majority of the lags accept the null hypothesis.

Table 6: Results of VECM test for serial correlation

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	Df
1	14.51117	0.5607	14.99488	0.5250	16
2	25.50378	0.7851	26.74559	0.7297	32
3	44.42113	0.6203	47.68981	0.4855	48
4	58.97631	0.6543	64.40131	0.4624	64
5	74.92061	0.6396	83.41183	0.3750	80
6	93.09265	0.5650	105.9451	0.2290	96
7	113.9927	0.4298	132.9410	0.0862	112
8	128.8509	0.4623	152.9673	0.0655	128
9	144.1134	0.4817	174.4735	0.0426	144
10	153.2173	0.6358	187.9126	0.0649	160
11	160.7491	0.7887	199.5870	0.1074	176
12	172.4728	0.8409	218.7151	0.0904	192

Results of VECM test for normality

Table 7 shows that in Jarque-Bera test are rejected for all residuals which indicate that they are all normal.

Table 7: Results of VECM test for normality

Component	Jarque-Bera	Df	Prob.
1	0.826077	2	0.6616
2	0.330175	2	0.8478
3	3.514592	2	0.1725
4	0.707476	2	0.7021
Joint	5.378320	8	0.7165

Granger Causality Analysis

The estimate results in table 8 shows that at 5% some of the variables Granger-causal for GDP. However, there is unidirectional causality between GDP growth rate and Exchange rate. This finding implies that GDP granger cause Exchange rate in Ghana. Also there is bidirectional causality between Inflation rate and Exchange rate, which implies that Inflation rate granger cause Exchange rate and visa versa in Ghana. Also there is bidirectional causality between Inflation rate and GDP, but there is no directional causality running from FDI and the selected macro-economic variables i.e. GDP, Exchange rate, Inflation and visa versa.

Table 8: Granger Causality Test

Null Hypothesis	F-statistics	Probability	Decision
Inflation does not Granger-cause GDP	7.47292	0.0026	Reject
GDP does not Granger-cause Inflation	10.6966	0.0004	Reject
FDI does not Granger- Cause GDP	2.78011	0.0798	Do not reject
GDP does not Granger- Cause FDI	0.63253	0.5389	Do not reject
Exchange rate does not Granger-cause GDP	1.92965	0.1647	Do not reject
GDP does not Granger-cause Exchange rate	5.12940	0.0129	Reject
FDI does not Granger- Cause Inflation	0.73683	0.4880	Do not reject
Inflation does not Granger- Cause FDI	1.48825	0.2437	Do not reject
Exchange rate does not Granger-cause Inflation	4.77628	0.0168	Reject
Inflation does not Granger-cause Exchange rate	30.1388	1.E-07	Reject
FDI does not Granger- Cause Exchange rate	0.06443	0.9378	Do not reject
Exchange rate does not Granger- Cause FDI	0.30033	0.7430	Do not reject

Conclusion

The co-integrated analysis and Granger causality test was applied in modelling the GDP growth of Ghana, with selected macro-economic variables such as FDI, exchange rates and inflation rates using yearly data for the period 1980-2013 obtained from Bank of Ghana and WDI, World Bank. The ADF tests and the KPSS test show that all the variables are integrated of order one, I (1).

The trace test and the max-eigenvalue test both indicate 1 co-integrating equation(s) at the 0.05 level. The estimated coefficient of the error correction model in the GDP growth equation is statistically significant and has a negative sign, which confirm the existence of a long-run equilibrium relationship between the independent and dependent variables at 5 per cent level of significance.

Furthermore, in the short-term relationships, the findings revealed a unidirectional causality between GDP growth rate and Exchange rate, which can be confirm from that of the short-term relationships in the VECM that Exchange does not have an impact on GDP. The granger causality test also shows bidirectional causality between Inflation rate and Exchange, and also between Inflation rate and GDP, whiles there was no directional causality running from FDI and GDP, Exchange rate and inflation.

Having established the fact that exchange rate has positive impact on growth domestic product, government should invest in local industries to boost domestic production of tradable which would maintain higher export volumes.

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